



# Closing the Loop in the Industrial Water Cycle

*Concerns about the environment and the sustainability of the earth's natural resources have accelerated rapidly to the forefront of global interest. In the midst of a global financial crisis, industrial manufacturing and processing operations are being confronted with the challenge of striking a balance between the environmental impacts of their activities and making a profit.*

The origins of the global mega-trend of sustainable development can be traced back to the Brundtland Commission's report in the 1980s, which made sustainability an international issue, defining sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The report has been hailed as one of the most influential documents of the last century — the actualisation of increasing worldwide concern about the environment. The Commission's brief was to re-examine critical environment and development problems on the planet and to formulate realistic proposals to solve them, creating a "global agenda for change".

The report approached the environmental and development issues confronting the world by representing them as one common challenge, to be approached by collective multilateral action, rather than through the pursuit of national self-interest. Not without its flaws, the Brundtland report nevertheless resulted in real global action — in the form of international agreements such as the Montreal Protocol on substances that deplete the ozone layer, the Kyoto Protocol, an international treaty designed to limit global greenhouse gas emissions, and international summits on sustainable development which have led to a comprehensive global plan of action in every area in which humans impact on the environment.

The Brundtland Report made a difference in the way people look at their world and how they make decisions that will affect the environment. The concept of sustainable development has extended planning horizons decades into the future. Companies who believe that environmental management is like managing another aspect of risk, with real business connotations, have an extremely enlightened outlook — it's a case of good business management.

Investors are also increasingly calling for better corporate performance and disclosure on social and environmental issues, using reporting standards created by the Global Reporting Initiative, prompting an ever-increasing number of companies to produce their own sustainability reports.

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## Water

Driven by growing pressure to control water costs and to adopt the sustainability agenda, manufacturing and processing companies throughout the world are starting to reuse and recycle their industrial water. Companies are gradually moving away from discharging their waste water to large, central municipal water treatment facilities, in favour of treating the discharge on-site for re-use.

Darren Gurney, Process Engineer, Water and Aquaculture, at The Linde Group says, "Companies today are looking at ways to close the loop in their water usage cycle. We've been tracking the rising interest in water re-use over a number of years and this has led to the development of technology that can treat industrial wastewater in a cost effective and environmentally sustainable manner for re-use by the company that generated it.

"We're making it possible for organisations to unlock the resources they already have in their processes, to increase capacity without further depleting a finite natural resource. The objective is to make it possible for companies who use water in their processes to treat the effluent on-site and recycle as much of it as possible back into the system for effective re-use. Companies are turning to this alternative against a background of increasing pressure, in the form of restrictions on allowable discharge volumes, limitations on borehole abstraction, legislative pressure and the upward spiralling costs of incoming water supply and trade effluent discharge.

"In developing this technology we've worked hard to achieve all the aims of re-use, whilst minimising costs and energy requirements. These aims include significantly reducing the demand on limited fresh water resources, retaining water near its original source, reducing secondary pollution, better utilisation of space on site, releasing manpower, reducing environmental impact and enhancing reliability. The result is a solution that gives companies independence, flexibility and a sustainable source of water supply into the future."

Instead of discharging waste water and engaging external water treatment companies to dispose of it in compliance with statutory requirements, Linde's new offering, AXENIS™, provides an alternative on-site water treatment for high strength industrial waste water – and one that offers savings as high as 30 % across the water lifecycle. It is a patented process which uses a combination of air and pure oxygen, for process optimisation control and low energy oxygenation for industrial wastewater treatment and water re-use. This biological treatment based process utilises ultra filtration (UF) for separation and reverse osmosis (RO) membranes which eliminate contaminants to produce various levels of water quality.

The technology achieves a reduction in surplus biomass wastage of up to 70 % compared with conventional air-based membrane bioreactors (AMBR) and typically requires about 20 to 25 % less power than a conventional AMBR. In its current evolution, AXENIS™ is able to recycle between 60 to 70 % if potable water quality is required, but as much as 100 % can be recycled as water to be used for washing down purposes. Compared with conventional water treatment and recycling solutions, AXENIS™ offers a lower lifecycle operating cost, flexibility and the added benefit of producing a re-usable utility.

## Energy Reduction

In terms of energy reduction, the AXENIS process uses the configuration of the UF membranes to harness the energy that is available after the separation of the biomass from the treated effluent, or permeate. The biomass must be routed back to the process to be used again in the treatment of soluble pollutants present in the influent wastewater. This usable energy is exploited to dissolve the oxygen



or air and to assist with process mixing in the bioreactor.

"Conventional AMBR systems based on air do not have this unique feature," says Gurney. "Instead they employ a separate device, which has a relatively high power demand because it receives no assistance from the separation stage, since the two are not connected. The AXENIS system uses around 50 to 65 % less energy as a result of this arrangement, depending on the nature of the wastewater and other key operating parameters."

Gurney says the fundamental technology behind AXENIS has been around for several years, but Linde has reconfigured and intensified it to make it more compact and more robust. AXENIS essentially delivers a high rate water treatment re-use system with flexible capacity and the benefits of an extended aeration system / process.

"Our water treatment activities have two thrusts," he says. "The first provides standard installations harnessing well known and established water treatment applications, while the other constantly strives to develop new products to serve the market. This team works on improving the water treatment equipment we already have to drive completely new applications where historically no gas was used, to improve customer efficiencies and achieve cost savings.

"AXENIS is the result of this product development programme. For us this is the first of a generation of technology that will use the AXENIS process as its core. On the Alpha version we're taking industrial wastewater to potable quality, while looking ahead to producing ultra-pure water for specific industrial use, such as in high pressure boilers.

Officially released in July this year, the process employs a high rate biological treatment stage and uses oxygen and air for optimum process control. Compared to conventional waste water treatment solutions, the innovative, patented process offers very substantial cost savings across the industrial water lifecycle. This includes

much reduced capital investment requirements which will be important for industries looking to capitalise on retrofittable water treatment solutions versus commissioning newly constructed plants, and decreased energy costs as the new system requires considerably less power than air-based systems.

A high bioreactor temperature also increases membrane flux rates, which has the added benefit of reducing membrane surface area, making the unit extremely compact and saving on plant footprint.

"The reactor can be at least half and, in some cases, as much as a third of the size of conventional membrane bioreactors for the same capacity," says Gurney.

Linde is presently working with its first reference customer on the first full scale AXENIS installation in the UK, together with its British technology partner Aquabio Ltd., who is providing engineering design input and project execution. The plant is a retrofit upgrade increasing capacity by over 30 % per day of waste water load and aiming to reach over 50 % when fully optimised. The first full scale greenfield site application is being negotiated and is likely to be commissioned during 2010, when capital is approved.

## The Future

"Linde has always had a strong heritage and pioneering role in developing environmentally sustainable technologies," concludes Gurney. "Our new AXENIS waste water treatment solution represents a real alternative for producers of high strength industrial waste water by delivering a highly convenient and cost-effective re-usable utility — and one that will have a vastly reduced impact on the environment.

"We are one of the few companies to be able to offer a comprehensive water recycling package solution. The current economic climate has created an ideal platform for innovation, with companies looking for larger returns on their investments. However, the water market is driven by market factors larger than cyclical events such as the recession and the investment cycle. Water re-use is an issue of global concern which overrides recessionary factors."